(12) UK Patent Application (19) GB (11) 2 262 905 (13) A

(43) Date of A publication 07.07.1993

(21) Application No 9127527.1

(22) Date of filing 31.12.1991

(71) Applicant
Ranleigh Limited

(Incorporated in Ireland)

Block A, Earlsfort Centre, Earlsfort Terrace, Dublin 2, Ireland

(72) Inventors
Graeme Lowe
Fergus McNamee

(74) Agent and/or Address for Service
Marks & Clerk
57–60 Lincoln's Inn Fields, London, WC2A 3LS, United Kingdom

(51) INT CL[5]
B29C 47/00 47/10 47/62

(52) UK CL (Edition L)
B5A AA1 AT17H AT17X A1G10 A1G5E A1R133 A1R420 A2A3 A2B2 A2D1X A2U6 A2U9 A20T16 A20T19

(56) Documents cited
GB 1165985 A EP 0046631 A US 4684488 A
Plastics extrusion technology-1988 Hanser publishers, pp168-191

(58) Field of search
UK CL (Edition K) B5A AA1 AD32 AT16H AT16J AT16S AT17H AT17J AT17S AT17X
INT CL[5] B29B, B29C

(54) **Extruding a sheet of mixed pigment and regrind/virgin plastics, for thermoforming**

(57) The components of the mixture are delivered from respective separate pigment, and regrind and virgin plastics hoppers 7, 8 6 into an infeed hopper 10, thence by delivery auger 15 into an extruder screw 5 which has a primary helical flight 41 and, in a transition zone 35, a secondary flight 46 which defines a channel 47 in which the material is thoroughly mixed. The diameter of the secondary helical flight 46 is approximately 99.17% of the diameter of the primary helical flight 41 and this achieves efficient material transfer into the channel 47 with reduced shearing and improved pumping action. The combination of the reduced diameter of the secondary flight 46 and the delivery auger 15 achieved efficient handling of materials with a high content of regrind material and change-over from one mix to another is achieved quickly with minimum wastage.

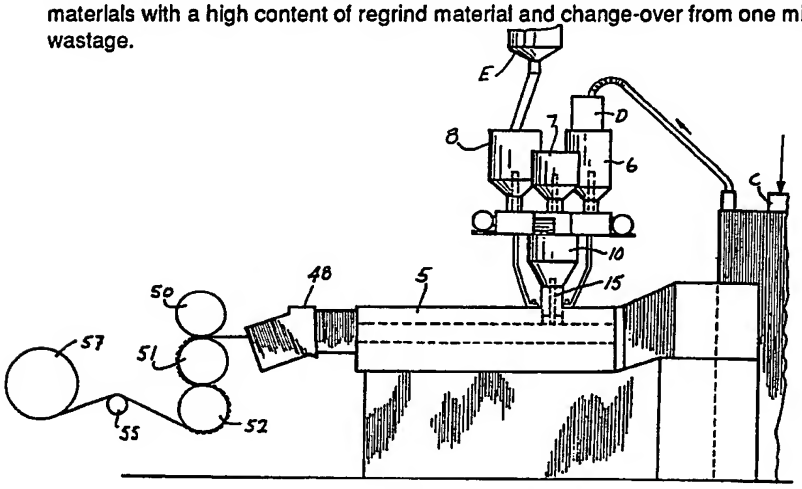

Fig.2

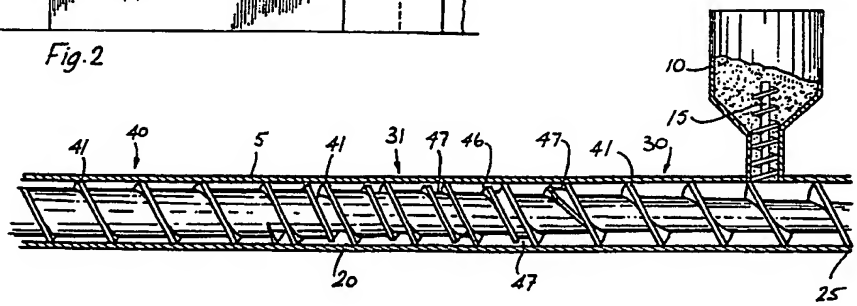

Fig.3

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 262 905 A

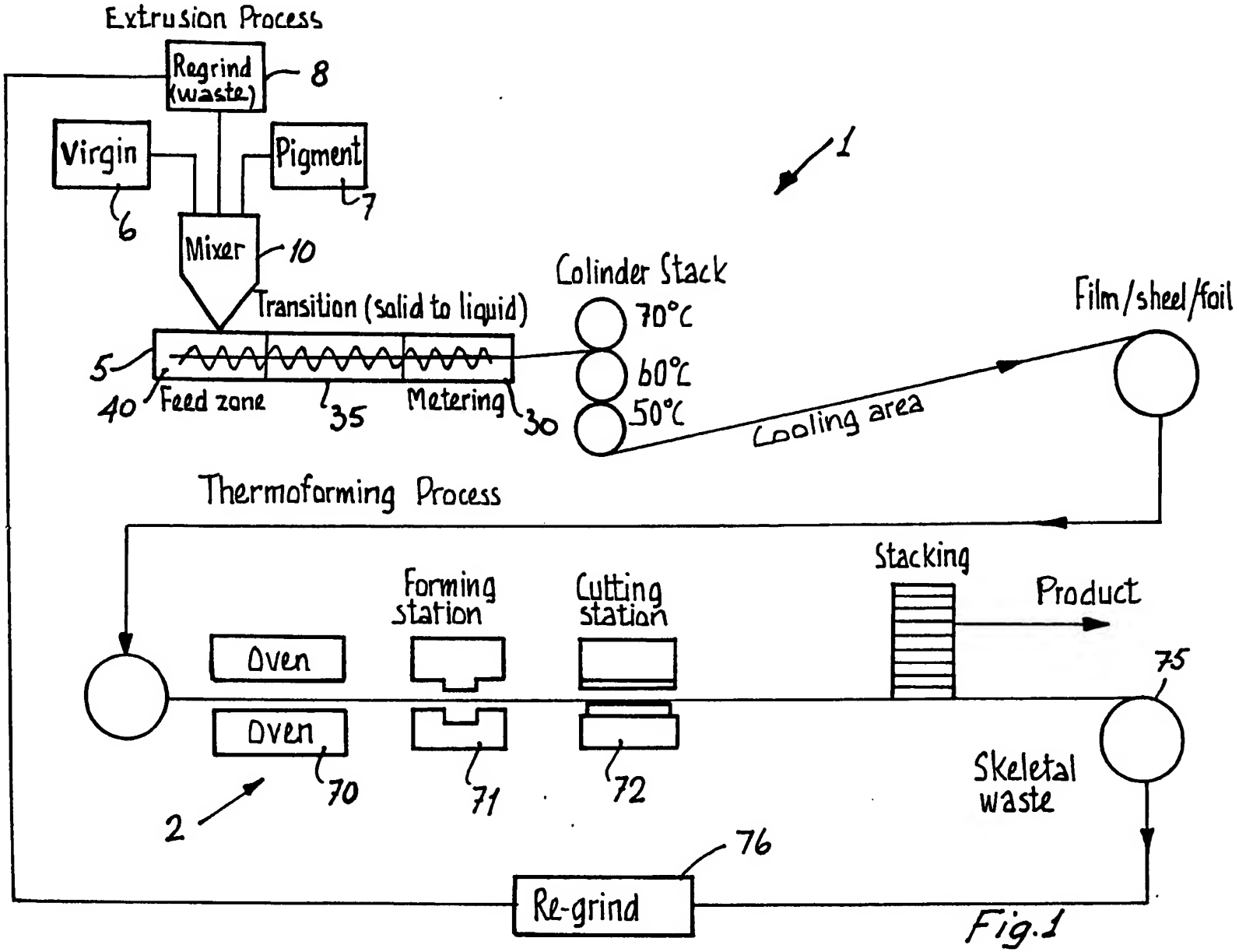
Extrusion Process
Regrind (waste)
8
Virgin
6
Pigment
7
Mixer
10
Transition (solid to liquid)
1
Colinder Stack
70°C
60°C
50°C
Film/sheel/foil
5
40
Feed zone
35
Metering
30
Cooling area
Thermoforming Process
Stacking
Forming station
Cutting station
Product
Oven
Oven
75
70
71
72
2
Skeletal waste
76
Re-grind

Fig. 1

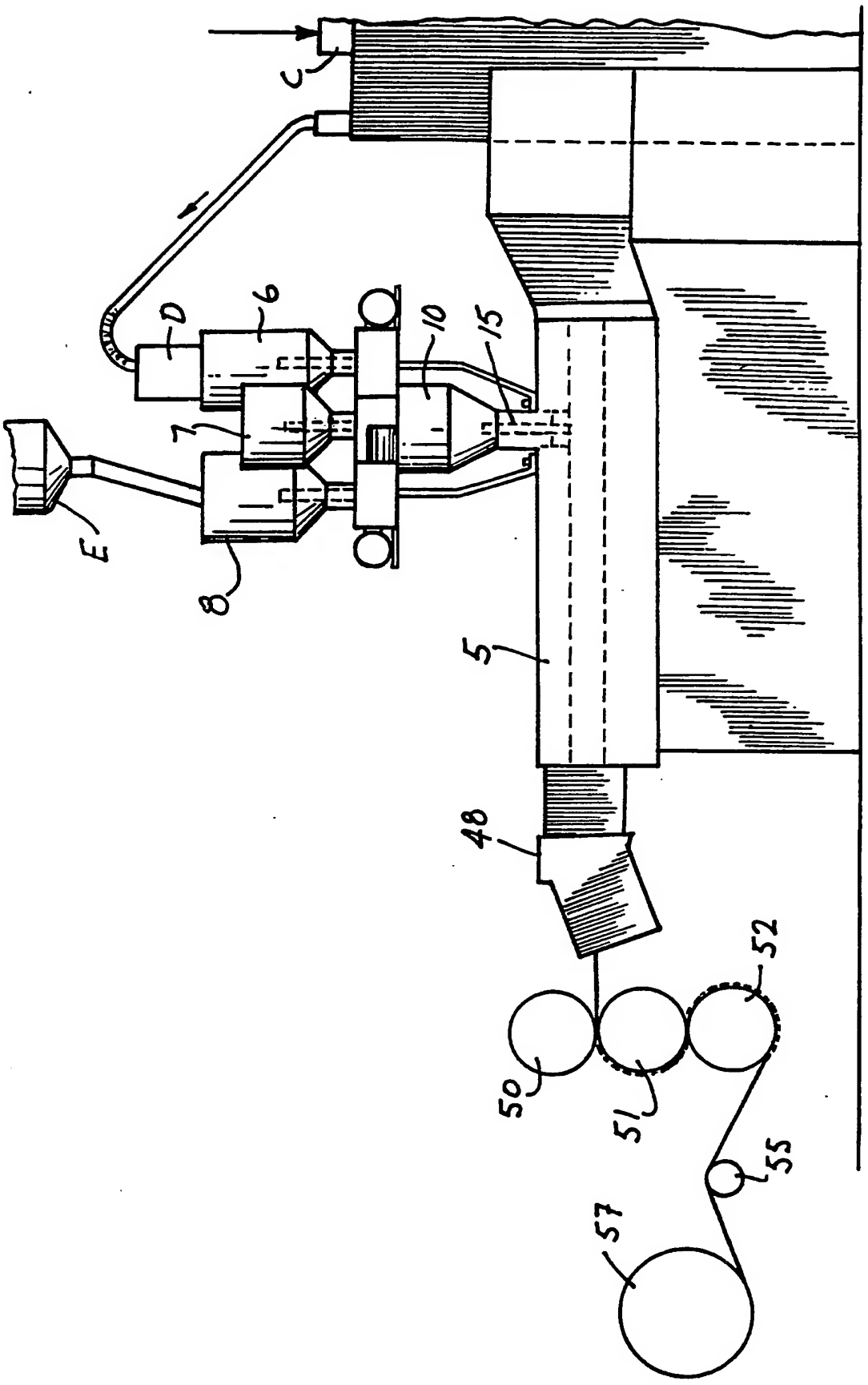

Fig.2

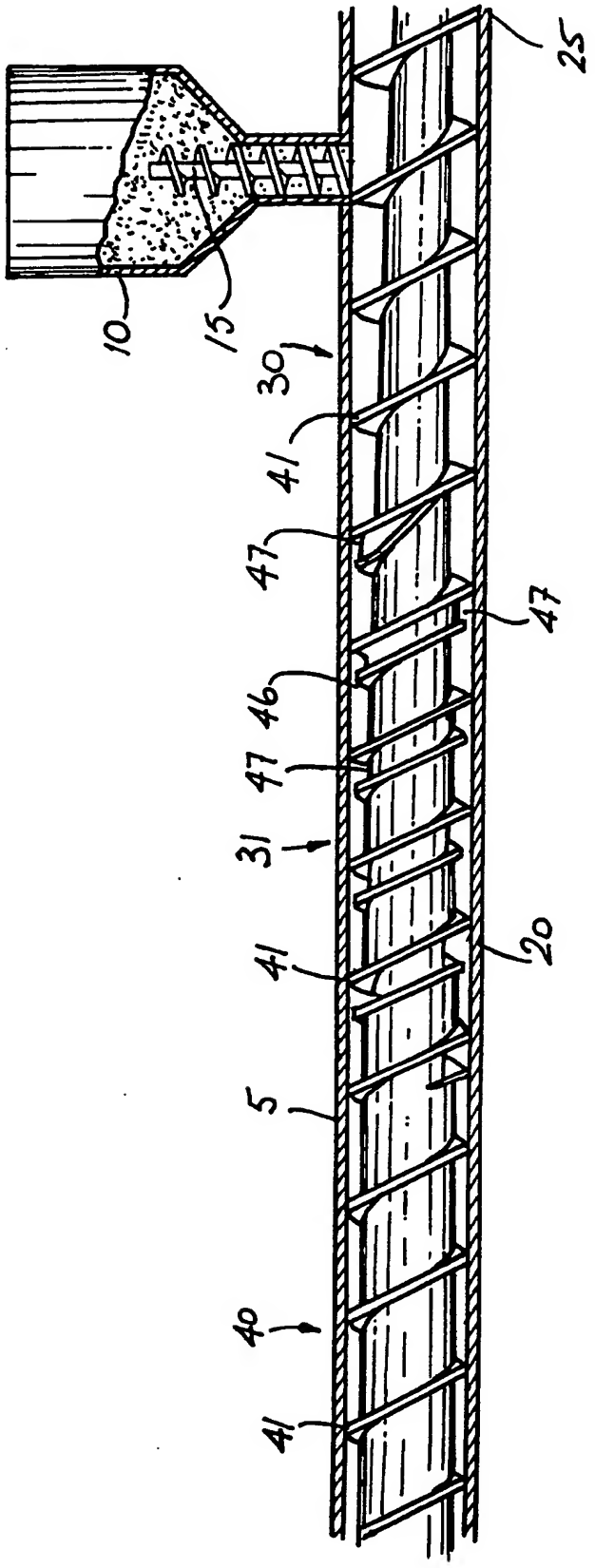

Fig.3

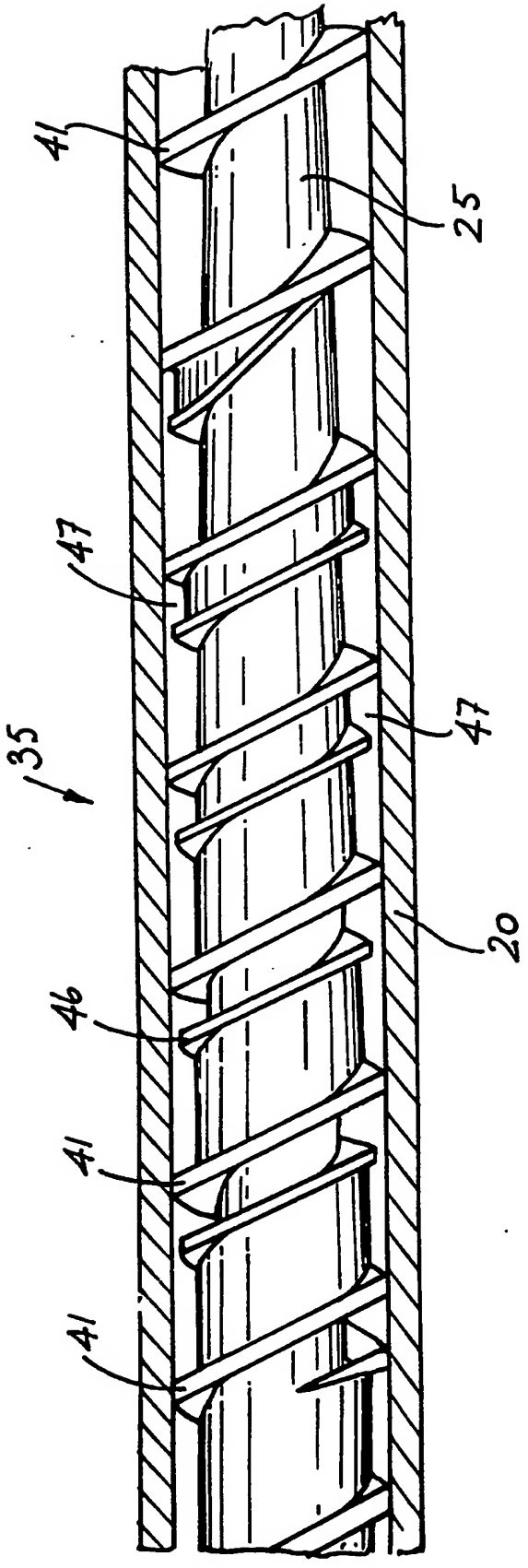

Fig.4

2262905

A Forming Process

The invention relates to a process for forming thin wall plastics packaging containers. The invention also relates to an apparatus for use in the process of the invention.

Conventional thin walled plastics containers are produced from a sheet of plastics material by a thermoforming process. It is vital that the sheets of plastics material be produced as efficiently as possible and be available, on demand, for thermoforming. This is particularly important where a large range of containers of different colours are to be produced.

In some cases, manufacturers buy in rolls of pre-formed plastics sheet, however this is not only costly but the quantity and availability of such material may be variable. Further, the thermoforming process produces a considerable amount of waste plastics material which is not only inefficient but which presents problems of storage and disposal.

In other cases, manufacturers have attempted to operate an integrated process in which they extrude on site the rolls of plastics material used in the thermoforming process. There are cost savings, however, it is difficult to operate such an extrusion process efficiently when a large range of plastics sheet material is required. In particular, there is considerable down-time and wastage involved in the changeover from extruding one colour sheet to another. Another problem is in re-processing the large quantity of waste plastics material generated in the thermoforming process.

This invention is directed towards providing an integrated process for producing thin walled plastics packaging containers which will overcome at least some of these problems.

According to the invention there is provided a process for forming thin walled plastics packaging containers comprising the steps of:

extruding plastics material into a sheet,

heating the sheet,

forming the heated sheet into a desired shape, and

cutting away excess material to provide a desired container,

material for extrusion into a sheet being delivered from a first hopper for virgin plastics material, optionally from a second hopper for plastics regrind material, and optionally from a third hopper for pigment material, by respective screw conveyors which deliver the material into an infeed hopper,

mixing the material in the infeed hopper,

further mixing and delivering the mixed material into a screw extruder by means of an auxiliary mixer which delivers the material from the infeed hopper into the barrel of a screw extruder having a single screw, having a primary helical flight with a diameter d_1,

passing the mixed material through a feed zone of the extruder,

passing the material through a transition zone of the extruder screw, the screw having a secondary helical flight in the transition zone which is spaced-apart from the primary flight to define a mixing channel therebetween in which the material

is mixed as it passes through the transition zone, the secondary helical flight having a diameter d_2 which is between 99.0% and 99.3% of the diameter d_1 of the primary helical flight,

passing the plasticised material through a metering zone of the extruder screw,

passing the plasticised material through a die which forms the plasticised material into a sheet,

cooling the plasticised sheet by leading it over successive calander rollers, and

winding the cooled sheet onto a roll from which the sheet is delivered for thermoforming into a desired container.

In a preferred embodiment of the invention the diameter d_2 of the secondary helical flight is between 99.1% and 99.2% of diameter d_1 of the primary helical flight.

Most preferably the diameter d_2 of the second helical flight is approximately 99.17% of the diameter d_1 of the first helical flight.

In one embodiment of the invention the width of the secondary channel between the primary and secondary flights in the transition zone is approximately 152mm.

In one embodiment of the invention the depth of the channel between the primary and secondary helical flights at the start of the transition zone is between 30 and 40mm, most preferably approximately 35mm.

In one arrangement the material for extrusion is mixed in the infeed hopper by a paddle type mixer.

In a particularly preferred arrangement, the material is delivered from the infeed hopper into the barrel of an extruder screw by an auxiliary screw.

In one embodiment of the invention, the sheet is cooled by passing the sheet over a first calander roller which is maintained at a temperature between 65°C and 75°C and subsequently over a second calander roller which is maintained at a temperature between 55°C and 65°C.

Preferably, the sheet is further cooled by passing it over a third calander roller which is maintained at a temperature of between 45°C and 55°C.

The invention also provides thin walled plastics packaging containers whenever prepared by the process of the invention.

The invention further provides an apparatus for forming a sheet of plastics material comprising:

a first feed hopper for virgin plastics material,

a second hopper for regrind plastics material,

a third hopper for pigment material,

an infeed hopper,

first, second and third auger conveyors for delivering material from the first, second and third hoppers respectively into the infeed hopper,

a main mixer in the infeed hopper for mixing the materials, and

an auxiliary mixer at an outlet of the infeed hopper for delivery of material into a screw extruder,

the screw extruder comprising a barrel having a cylindrical bore and a screw extending though the bore,

the screw extruder comprising a feed zone, a transition zone and a metering zone,

the screw of the extruder having a primary helical flight and a secondary helical flight in a transition zone of the screw,

the secondary helical flight being spaced-apart from the primary flight in the transition zone to define a mixing channel therebetween, the secondary helical flight having a diameter d_2 which is between 99.0% and 99.3% of the diameter d_1 of the primary helical flight,

a die at the outlet of the barrel of the extruder through which plasticised mixed material is lead and formed into a sheet,

calander rollers over which the formed sheet is led to progressively cool the sheet,

pull rollers for tensioning the sheet, and

a wind-up roller onto which the formed plastics sheet is led.

In one embodiment of the invention, the diameter d_2 of the secondary helical flight is between 99.1% and 99.2% of the diameter d_1 of the primary helical flight.

Preferably, the diameter d_2 of the secondary helical flight is approximately 99.17% of the diameter d_1 of the primary helical flight.

In a preferred embodiment of the invention, the width of the secondary channel between the primary and secondary helical flights in the transition zone in between 140 and 160mm, must preferably be approximately 152mm.

In one embodiment of the invention the depth of the secondary channel between the primary and secondary helical flight at the start of the transition zone is between 30 and 40mm, most preferably approximately 35mm.

In one arrangement, the main mixer in the outlet hopper comprises a paddle type mixer.

In a particularly preferred arrangement, the auxiliary mixer comprises a screw type mixer.

The invention will be more clearly understood from the following description thereof given by way of example only with reference to the accompanying drawings in which:-

Fig. 1 is a block diagram of the forming process of the invention;

Fig. 2 is a schematic side elevational view of part of the apparatus used in the process;

Fig. 3 is a side, partially cross-sectional view of an extruder screw forming part of the apparatus; and

Fig. 4 is a perspective, partially cross-sectional view on an enlarged scale of part of the screw of Fig. 3.

Thin walled plastics packaging containers such as trays used for packaging food and the like are formed in the process of the invention by first extruding plastics material into a sheet in a process which is indicated generally by the reference numeral 1 in Fig. 1 and subsequently thermoforming the plastics sheet into a desired container by a process which is indicated generally by the reference numeral 2 in Fig. 1.

Material for extrusion into a sheet is delivered to an extruder screw 5 from a first hopper 6 for virgin plastics material, a second hopper 7 for pigment or colour material and a third hopper 8 for reground plastics material.

Virgin plastics material is delivered to the hopper 6 from a large external silo A which feeds an internal silo B by means of a vacuum receiver C. Virgin material from the internal silo B is delivered into the hopper 6 by a vacuum receiver/hopper loader D. The hopper 7 is manually supplied with pigment material, as required. Waste plastics material from the thermoforming process is reground and supplied to the hopper 8 from an overhead silo E.

Material from the hoppers 6, 7, 8 is delivered by respective augers into an infeed hopper 10 in which the material is mixed by a paddle type mixer (not shown). Regrind material is supplied to the hopper 10 at constant speed and the feed mix is varied as required by altering the speed of the motors driving the feed augers for the virgin plastics and pigment material.

An auxiliary mixer, in this case provided by an auger or delivery screw 15, further mixes and delivers the mixed material from the infeed hopper 10 into the screw extruder 5. The auxiliary delivery screw and mixer 15 which is shown in more detail in Fig 3 is of vital importance in ensuring that bridging of the outlet of the hopper 10 is avoided and in delivering plastics material from the infeed hopper 10 to the extruder 5 as thoroughly mixed as possible. The positive delivery of the mixed material into the screw extruder in this way ensures continuous flow of material through the extruder

screw. By providing such an additional feeding and mixing screw the extruder may be operated with an infeed plastics material with a relatively high proportion of regrind plastics material.

Referring particulary to Figs. 3 and 4, the extruder screw 5 comprises a cylindrical barrel 20 with a bore of 635mm diameter and having a single screw extending therethrough. The screw comprises a shaft 25 having a root diameter of 375mm and which has a longitudinal axis which is coaxial with the axis of the barrel 20. The extruder screw 5 is divided into three zones namely, a feed zone 30 in which material to be extruded is thoroughly mixed, heated and softened, a transition zone 35 in which the material is melted and thoroughly mixed and, a metering zone 40 which completes the extrusion process and positively pumps plasticised material from the extruder screw 5.

The screw comprises a primary helical flight 41 having a diameter of 615.94mm with a radial clearance in the bore of 1.016mm. The flight 41 has a pitch of 635mm and a width of 63.5mm. The depth of the channel defined by the shaft 25 and primary helical flight 41 is 120mm in the feed zone 30 and decreases through the transition zone 35 to a depth of 53mm in the metering zone of the screw.

A secondary helical flight 46 is provided in the transition zone 35 of the screw. The secondary flight has a diameter of 610.9mm and a width of 31.75mm. In the transition zone, the secondary flight 46 is spaced-apart from the primary flight 41 and defines a secondary channel 47 having a width of 152.4mm. The depth of the secondary channel 47 increases through the transition zone from an initial depth of 35mm.

In the feed zone 30 the configuration of the primary flight 41 with respect to the shaft 25 and the bore of the screw defines a channel having a relatively large volume to heat and soften the plastics material which is introduced into the screw.

In the transition zone 35 the configuration of the primary channel shears the plastics material to homogenise the melt. As the material passes through the transition zone, it passes over the secondary flight 46 into the secondary channel 47 where the material is thoroughly mixed and the pigment is thoroughly dispersed.

In the metering zone 40 the mixed and plasticised material is positively pumped out of the screw.

Because of the reduced diameter of the secondary helical flight 46 good material transfer into the secondary channel is achieved with reduced shearing action and improved pumping

action. This is important in the case of feed material having a high percentage of regrind material with a high bulk density.

The configuration of the feed mixer and extruder screw contributes significantly to forming plastics material into sheets very efficiently and with minimum wastage. In particular, as mentioned above, material with a high content of regrind material may be readily processed. Further, because of the configuration of the extruder screw, especially of the reduced diameter of the secondary flight in the transition zone, material is quickly processed and the changeover time from one raw material mix to another is significantly shorter than heretofore. Thus, there is minimum wastage at changeover, for example when changing from one colour to another, and the changeover is achieved rapidly.

Material exiting from the extruder screw 30 is passed through a die 48 having a coat hanger shaped slot (not shown) which forms the plasticised material into a continuous sheet which is then passed over a series of calanders namely first, second, and third calanders 50, 51 and 52. The first calander 50 is maintained at a temperature of approximately 70°C, the second calander 51 is maintained at a temperature of approximately 60°C, and the third calander 52 is maintained at a temperature of approximately 50°C so that the sheet is gradually cooled as it passes through the calander stack.

When the sheet exits the third calander 52 it passes along a conveyor where it is further cooled by ambient air and pulled by means of gripping rollers 55 which tension the sheet before winding onto a reel 57.

The gauge of the material formed by the process of the invention is typically between 250 micro meters and 1000 micro meters and the width of the sheet is between 350mm and 860mm.

Sheets of plastics material formed by the extrusion process and apparatus described above are then passed to the thermoforming process 2 in which the sheets are first heated in an oven 70, and thermoformed into a desired shape at a forming station 71. The formed sheets are then passed to a cutting station 72 where excess material is trimmed off and the containers formed are stacked and packaged for transport. Skeletal waste from the cutting step 72 is collected in a bin 75, is reground in a regrinding step 76, and recycled to the regrind hopper 8.

Many variations of the specific embodiment of the invention described will be readily apparent and accordingly the invention is not limited to the embodiments hereinbefore described which may be varied in both construction and detail.

CLAIMS

1. A process for forming thin walled plastics packaging containers comprising the steps of:

extruding plastics material into a sheet,

heating the sheet,

forming the heated sheet into a desired shape, and

cutting away excess material to provide a desired container,

material for extrusion into a sheet being delivered from a first hopper for virgin plastics material, optionally from a second hopper for plastics regrind material, and optionally from a third hopper for pigment material, by respective screw conveyors which deliver the material into an infeed hopper,

mixing the material in the infeed hopper,

further mixing and delivering the mixed material into a screw extruder by means of an auxiliary mixer which delivers the material from the infeed hopper into the barrel of a screw extruder having a single

screw, having a primary helical flight with a diameter d_1,

passing the mixed material through a feed zone of the extruder,

passing the material through a transition zone of the extruder screw, the screw having a secondary helical flight in the transition zone which is spaced-apart from the primary flight to define a mixing channel therebetween in which the material is mixed as it passes through the transition zone, the secondary helical flight having a diameter d_2 which is between 99.0% and 99.3% of the diameter d_1 of the primary helical flight,

passing the plasticised material through a metering zone of the extruder screw,

passing the plasticised material through a die which forms the plasticised material into a sheet,

cooling the plasticised sheet by leading it over successive calander rollers, and

winding the cooled sheet onto a roll from which the sheet is delivered for thermoforming into a desired container.

2. A process as claimed in claim 1 wherein, the diameter d_2 of the secondary helical flight is between 99.1% and 99.2% of the diameter d_1 of the primary helical flight.

3. A process as claimed in claim 1 or claim 2 wherein the diameter d_2 of the secondary helical flight is approximately 99.17% of the diameter d_1 of the first helical flight.

4. A process as claimed in any of claims 1 to 3 wherein the width of the secondary channel between the primary and secondary helical flights in the transition zone is between 140 and 160mm.

5. A process as claimed in claim 4 wherein the width is approximately 152mm.

6. A process as claimed in any preceding claim wherein the depth of secondary channel between the primary and secondary helical flights at the start of the transition zone is between 30 and 40mm.

7. A process as claimed in claim 6 wherein the depth is approximately 35mm.

8. A process as claimed in any preceding claim in which the material for extrusion is mixed in the infeed hopper by a paddle type mixer.

9. A process as claimed in any preceding claim wherein the material is delivered from the infeed hopper into the barrel of an extruder screw by an auxiliary screw.

10. A process as claimed in any preceding claim wherein the sheet is cooled by passing the sheet over a first calander roller which is maintained at a temperature between 65°C and 75°C and subsequently over a second calander roller which is maintained at a temperature between 55°C and 65°C.

11. A process as claimed in claim 7 wherein the partially cooled sheet is led over a third calander roller which is maintained at a temperature of between 45°C and 55°C.

12. A process substantially as hereinbefore described with reference to the accompanying drawings.

13. Thin walled plastics packaging containers whenever prepared by a process as claimed in any preceding claim.

14. Apparatus for forming a sheet of plastics material comprising;

a first feed hopper for virgin plastics material,

a second hopper for regrind plastics material,

a third hopper for pigment material,

an infeed hopper,

first, second and third auger conveyors for delivering material from the first, second and third hoppers respectively into the infeed hopper,

a main mixer in the infeed hopper for mixing the materials, and

an auxiliary mixer at an outlet of the infeed hopper for delivery of material into a screw extruder,

the screw extruder comprising a barrel having a cylindrical bore and a screw extending though the bore,

the screw extruder comprising a feed zone, a transition zone and a metering zone,

the screw of the extruder having a primary helical flight and a secondary helical flight in a transition zone of the screw,

the secondary helical flight being spaced-apart from the primary flight in the transition zone to define a mixing channel therebetween, the secondary helical flight having a diameter d_2 which is between 99.0% and 99.3% of the diameter d_1 of the primary helical flight,

a die at the outlet of the barrel of the extruder through which plasticised mixed material is lead and formed into a sheet,

calander rollers over which the formed sheet is led to progressively cool the sheet,

pull rollers for tensioning the sheet, and

a wind-up roller onto which the formed plastics sheet is led.

15. Apparatus as claimed in claim 14 wherein the diameter d_2 of the secondary helical flight is between 99.1% and 99.2% of the diameter d_1 of the primary helical flight.

16. An apparatus as claimed in claim 14 or 15 wherein the diameter d_2 of the secondary helical flight is approximately 99.17% of the diameter d_1 of the primary helical flight.

17. Apparatus as claimed in any of claims 14 to 16 wherein the width of the secondary channel between the primary and secondary helical flights in the transition zone is between 140 and 160mm.

18. Apparatus as claimed in claim 17 wherein the width is approximately 152mm.

19. Apparatus as claimed in claim 18 wherein the depth of the secondary channel between the primary and secondary helical flight at the start of the transition zone is between 30 and 40mm.

20. Apparatus as claimed in claim 19 wherein the depth is approximately 35mm.

21. Apparatus as claimed in any of claims 14 to 20 in which the main mixer in the outlet hopper comprises a paddle type mixer.

22. Apparatus as claimed in any of claims 14 to 21 wherein the auxiliary mixer comprises a screw type mixer.

23. Apparatus substantially as hereinbefore described with reference to the accompanying drawings.

24. A reel of plastics material whenever formed using an apparatus as claimed in any of claims 14 to 23.

ks\B:91\dec\renlauk.dec

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
9127527.1

Relevant Technical fields

(i) UK Cl (Edition K) B5A:AA1;AT16H;AT16J;AT16S; AT17H;AT17J;AT17S;AT17X;AD32

(ii) Int Cl (Edition 5) B29B:B29C

Search Examiner
A J M TAJASQUE

Databases (see over)
(i) UK Patent Office

(ii)

Date of Search
6 APRIL 1992

Documents considered relevant following a search in respect of claims 1-24

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
Y	US 4684488 (WERNER & FLEIDERER) Figure 1	1 and 14 at least
Y	GB A 1165985 (N R M CORPN) Page 4, lines 27-58	1 and 14 at least
Y	EP A 0046631 (CROMPTON & KNOWLES) Page 9, lines 1-8; page 10, lines 6-11 and 20-23	1 and 14 at least
Y	PLASTICS EXTRUSION TECHNOLOGY 1988 HANSER PUBLISHERS PAGES 168-191	1 and 14 at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

Published 1993 at The Patent Office, Concept House, Cardiff Road, Newport, Gwent NP9 1RH. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.